Wind and Wind Stress Measurements in HiRes

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LONG-TERM GOALS

The long-term goals are to further the understanding of air-sea interaction processes including momentum, heat, water vapor, surface and boundary layer dynamics under various meteorological and oceanographic conditions.

OBJECTIVES

The objectives of this grant are to measure and analyze the wind, wind stress and associated quantities at sea in the High Resolution Air-Sea Interaction DRI (HiRes). The practical objectives of Hi-Res are the determination of how well ship-based radars can measure the phase-resolved surface wave field (PRSWF), testing the skill of highly-nonlinear numerical surface wave models to predict the evolution of the PRSWF, and the incorporation of ocean wave effects into models of the Marine Atmospheric Boundary Layer (MABL).

APPROACH

The HiRes grant started in April 2008. The initial phase of the research is to design the experimental system to be conducted on R/P FLIP. Data from a past experiment are also being analyzed with respect to processes relevant to HiRes.

WORK COMPLETED

A trial cruise on R/P FLIP was performed in July 2009. The UCI meteorological mast was deployed with representative sensors that will be used in the main experiment in 2010. These included:

1. Sonic anemometers for three-dimensional mean and turbulent winds
2. Cup and vane anemometers for mean winds
3. Candidate propeller-vane anemometer to replace cups and vanes
4. Thermistors for air temperature in fan-aspirated solar radiation shields
5. Precision barometers for mean and fluctuating pressure (T. Hristov, Johns Hopkins)
6. Modified Krypton hygrometer for fast-response humidity

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7. Oxford GPS/inertial navigation and reference unit
8. National Instruments data system (105 signals) with GPS module

RESULTS

The UCI meteorological mast was deployed on the new port boom on FLIP with minor adjustments made in the field. The new boom provides double the capacity of the old boom (800 lb load at the end). Flipping the UCI mast was accomplished with the aid of the FLIP crew.

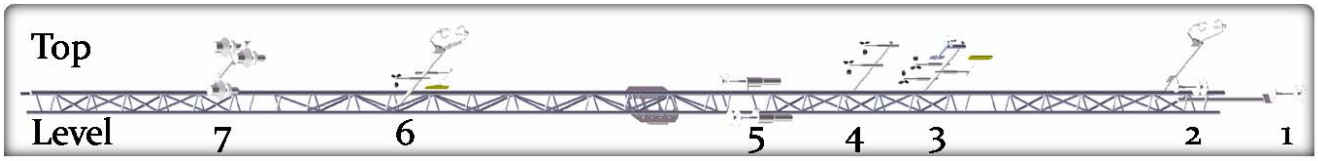

Figure 1: Fully assembled mast with sensors at each level : Level 1 – Paroscientific Barometer; Level 2 – Paroscientific Barameter, Campbell Sonic Anemometer; Level 3- 2x Met One Cup, Met One Vane, RM Young Propeller; Level 4 – 2x Met One Cup; Level 5 – 2x Paroscientific Barometer; Level 6 – Campbell Sonic Anemometer, Modified Krypton Hygrometer, Met One Cup, Met One Vane; Level 7 – 2x RM Young Aspirated Radiation Shield, EG&G Aspirated Radiation Shield.

The UCI meteorological mast consists of 4 parts, 3-10ft sections and 1-20ft section. The 20ft section in the middle includes the hinge point. When fully assembled the overall length of the mast is 50ft. For the HiRes trial in July 2009 we populated the mast with 7 levels. The goal of the trial cruise was mainly to compare different sensors in order to select those for the main experiment in June 2010. Of these, the RM Young fan-aspirated solar radiation shield proved superior to the existing UCI EG&G shields, which are significantly heavier. This comparison was done at level 7 and the results are shown in the following plot.

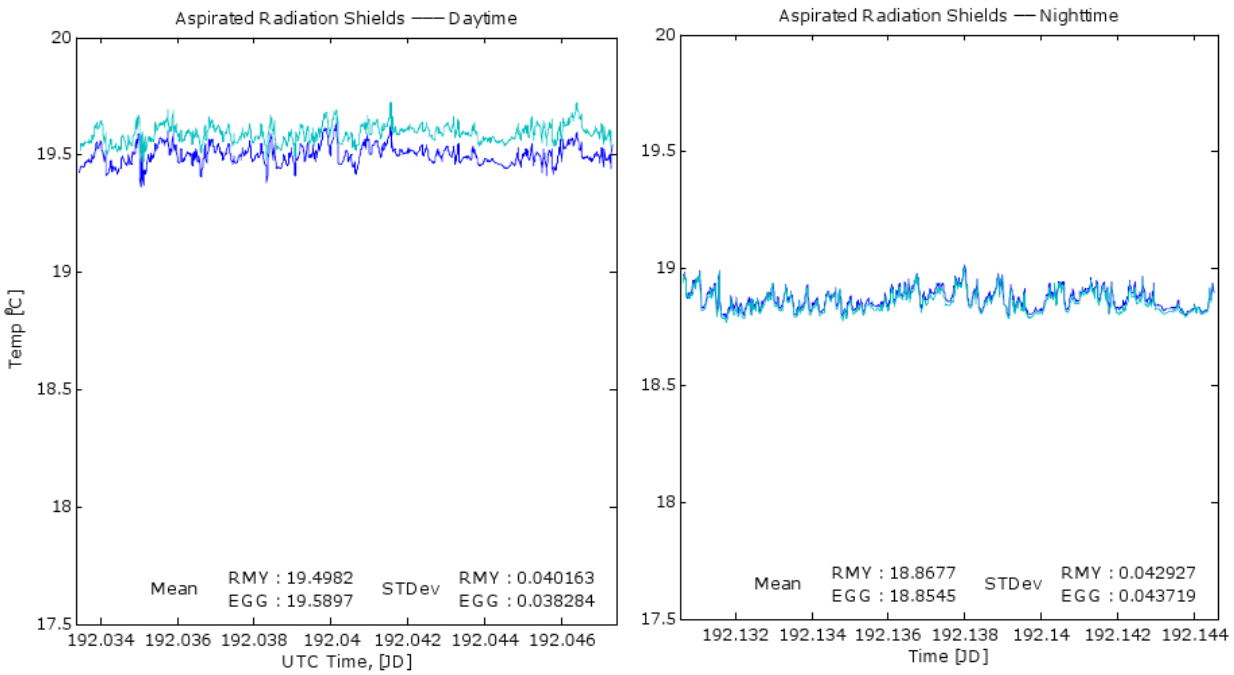

Figure 2: Blue – RM Young Aspirated Radiation Shield ; Cyan – EG&G Aspirated Radiation Shield. RM Young gives a better (lower) air temperature under daytime solar radiation.

At level 6, Cup and sonic anemometer comparisons of the horizontal wind speed vector were within expected tolerances.

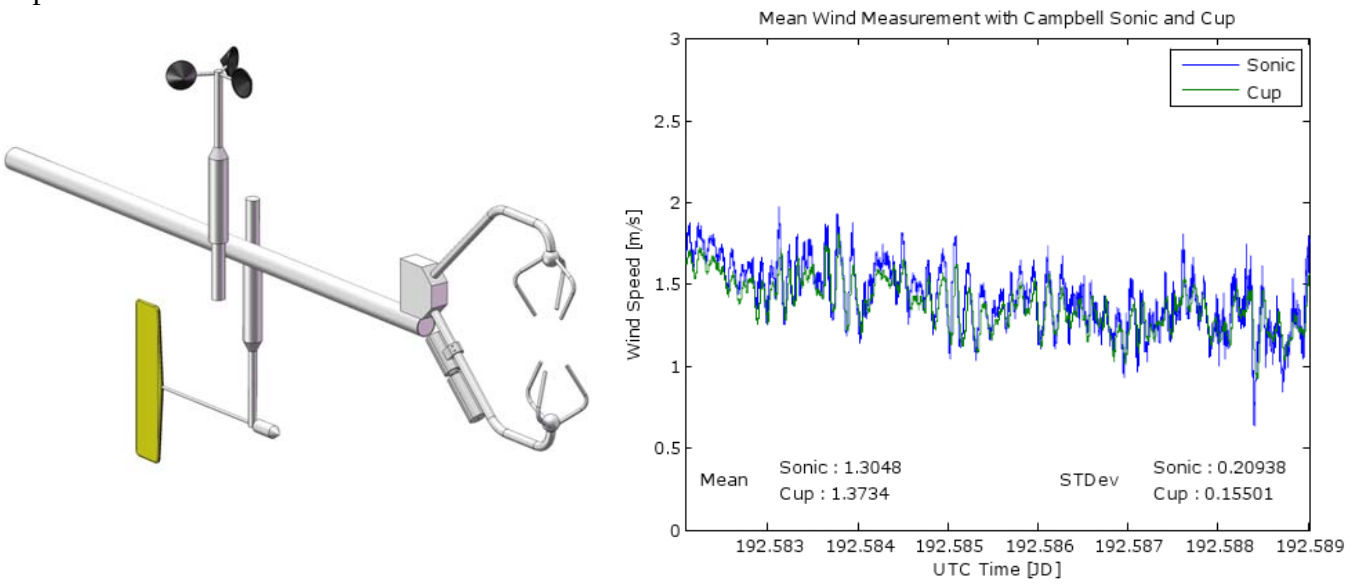

Figure 3: Level 6 along mast, with the results showing comparison of mean wind with Campbell Sonic Anemometer and Met One Cup Anemometer. Also a modified Krypton KH20 Hygrometer mounted on the lower sonic strut is shown.

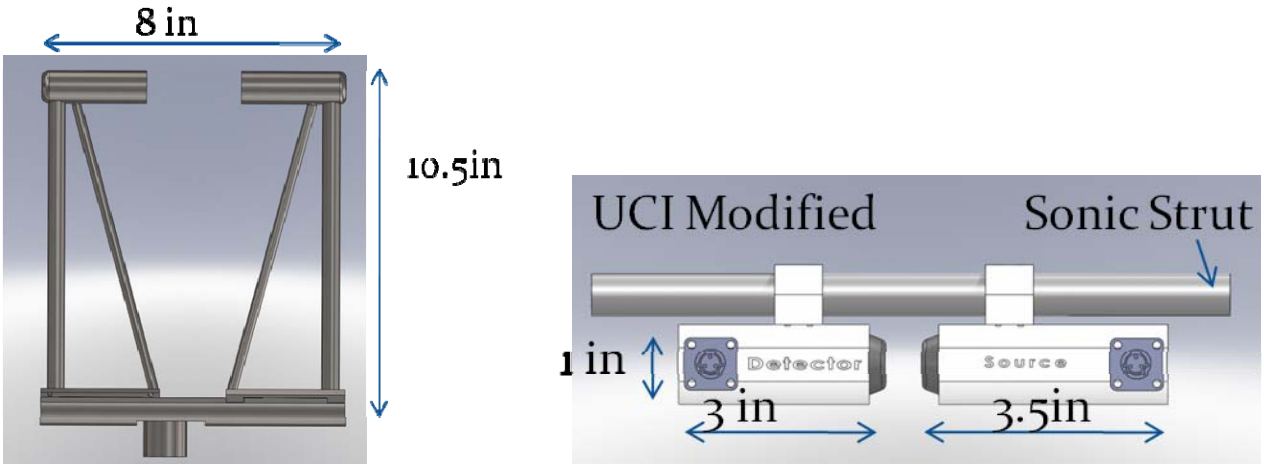

Figure 4: Modified Campbell Krypton hygrometer. The standard hygrometer requires an individual mount on the mast and is bulky. The size of the modified krypton hygrometer makes it easily mountable on a sonic strut. This allows for the measurement of the water vapor locally at the sonic for the calculation of the water vapor flux.

However, comparison of the cup anemometer and a RM Young propeller anemometer was not good; further tests of the RM Young anemometer are required. More studies will be done in a UCI closed return wind tunnel for comparisons. The RM Young anemometers will be simpler to install on the UCI mast and have fewer cables.

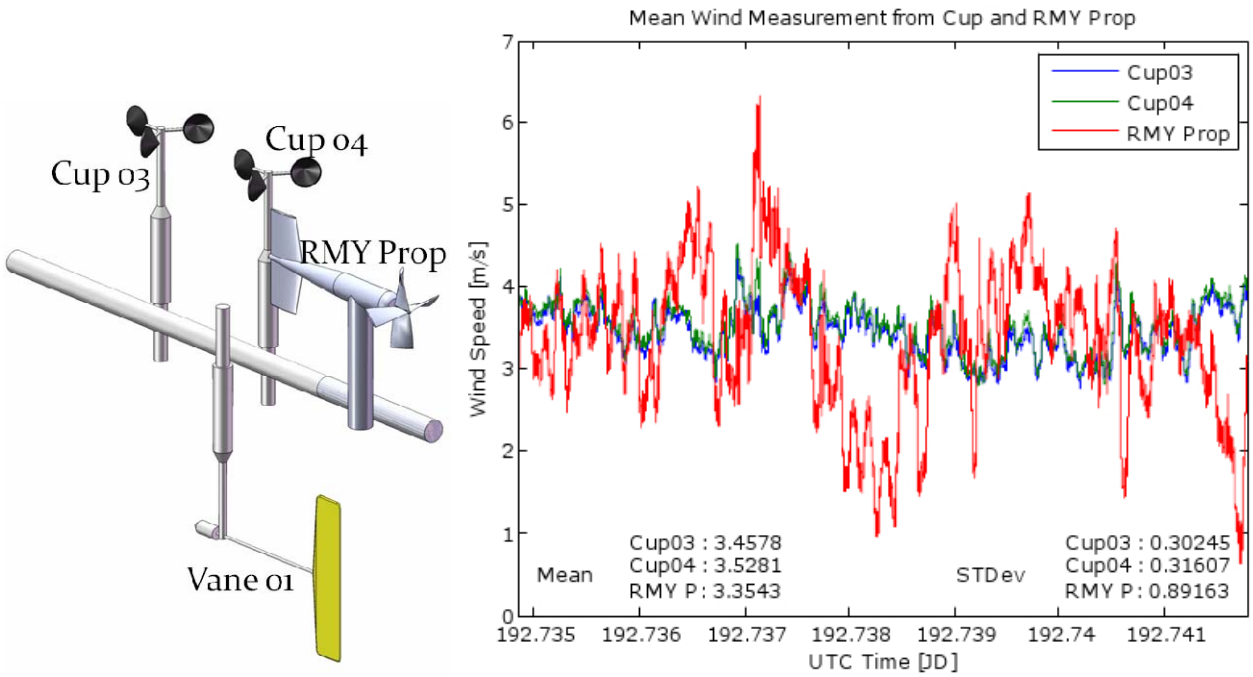

Figure 5: Level 3 on mast shows comparison of the mean wind as measured by Met One Cup Anemometers and a RM Young Propeller Anemometer.

The Paroscientific Precision barometers of Dr T. Hristov of The Johns Hopkins University were installed and worked well. An excellent comparison of two at the same level was obtained. (For further information, see the Annual Report by Dr T. Hristov.) Some problems were encountered on various signals due to possible grounding effects. The Oxford GPS/inertial navigation system was installed under the FLIP's and a HiRes WAMOS radar antennas on the top mast. There were periods where there may have been radar interference. In the main experiment, the Oxford GPS/inertial navigation system will be installed on the port boom where there is no interference anticipated.

IMPACT/APPLICATIONS

The initial application of these instruments will be in the ONR High Resolution Wind-Wave Departmental Research Initiative, FY2007-FY2011 during the main experiment in Spring 2010.

TRANSITIONS

RELATED PROJECTS

ONR High Resolution Wind-Wave Departmental Research Initiative, FY2007-FY2011.

REFERENCES

Not applicable

PUBLICATIONS

Not applicable

PATENTS

Not applicable

HONORS/AWARDS/PRIZES

Not applicable